FCAI Finnish Center for Artificial Intelligence

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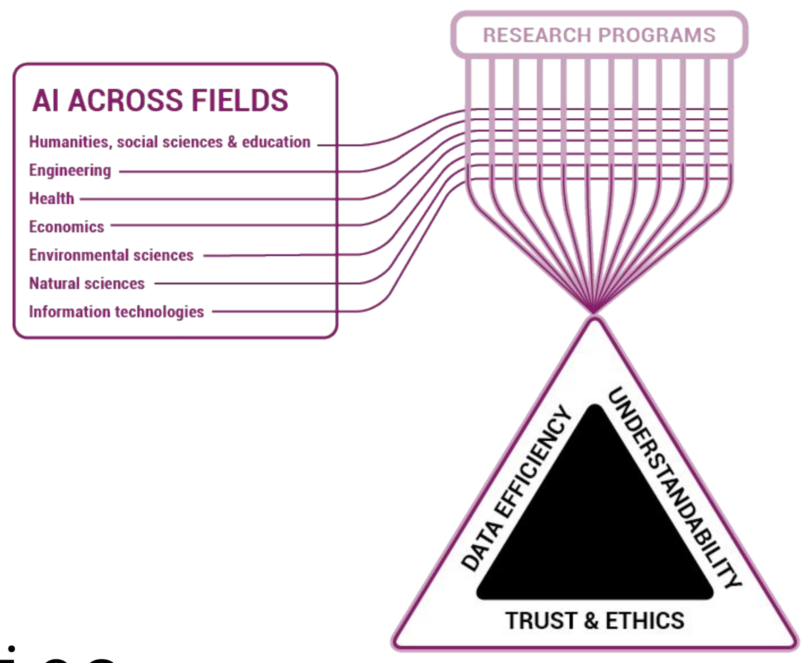


Applications of AI in healthcare (Highlight B)

FCAI Highlight Program B creates AI tools to tackle real-world problems in healthcare together with expert collaborators from the respective fields

Program objectives

Application B1: AI for genetics (Contact: Samuli Ripatti, UH)

We will create AI to analyze multivariate but structured genotype and phenotype data. The FinnGen project combines genetic data and electronic health records for 500,000 Finns. In collaboration with FinnGen we apply the AI tools to find genes modifying disease risk, progression, and comorbidities. [1,2]

Application B2: Computational vaccines (Contact: Jukka Corander, UH)

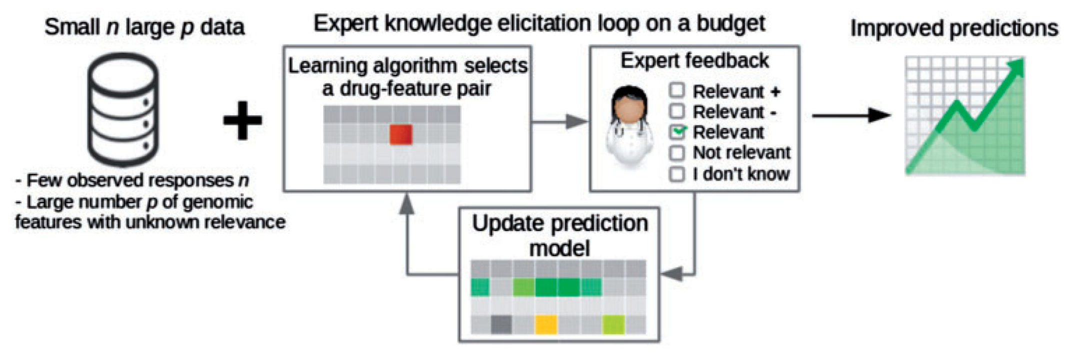
We will develop an AI-driven R&D tool for digital engineering of bacterial vaccines, using population genomic surveillance data combined with experiments to make probabilistic predictions of campaign effects for candidate vaccines and to identify optimal formulations. The tool will significantly accelerate development of new vaccines and has large implications for global health. [3]

Application B3: Healthcare resource allocation (Contact: Pekka Marttinen, Aalto)

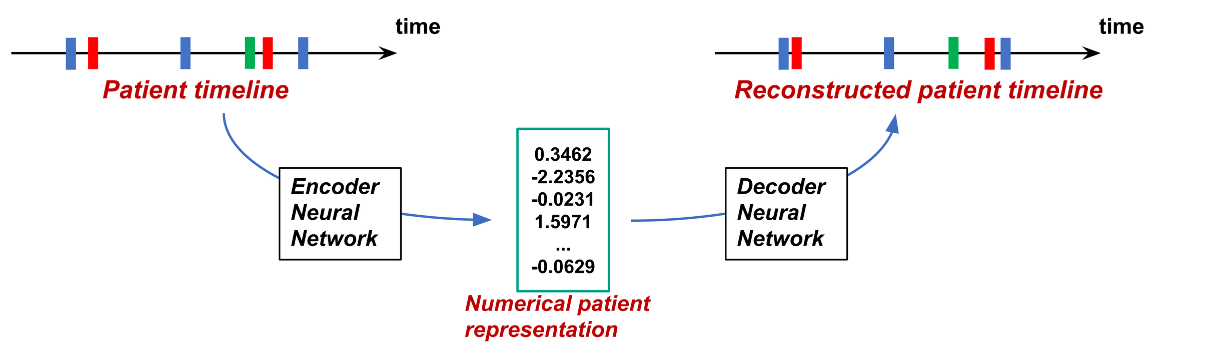
We will create AI for prediction of healthcare services and train it on nation-wide healthcare register data, in collaboration with the National Institute for Health and Welfare (THL). The platform can predict healthcare costs of individuals and will be used to allocate resources to healthcare providers in a fair and efficient way. It will also be used to assess and compare treatment practices across the country to identify the most effective ones. [4]

Example methodologies

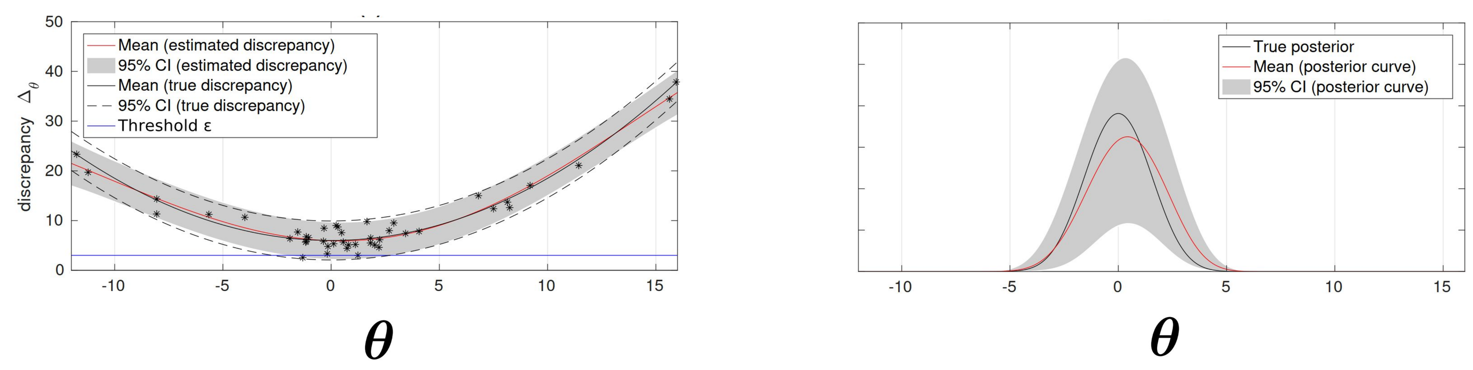
Interpretable and interactive machine learning [5]



Deep neural networks and generative models [4,6]



Model-based likelihood-free inference [7]

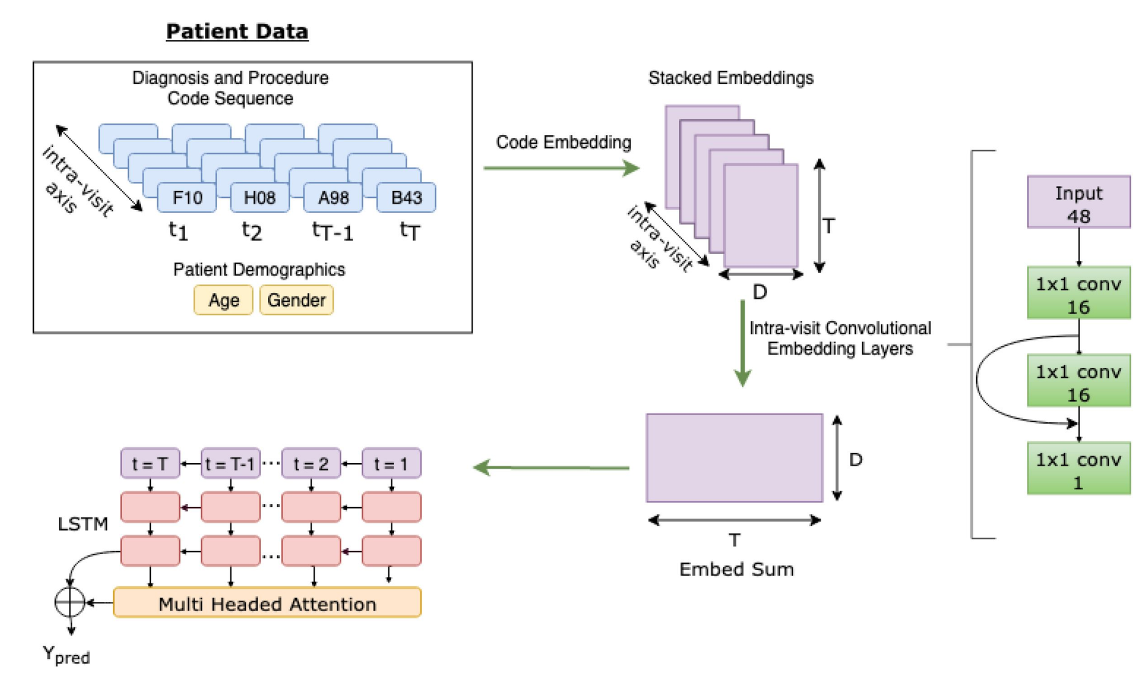


Model for the discrepancy between simulated and observed data for different parameter values.

The estimated posterior distribution for the model parameter.

Selected results

A)

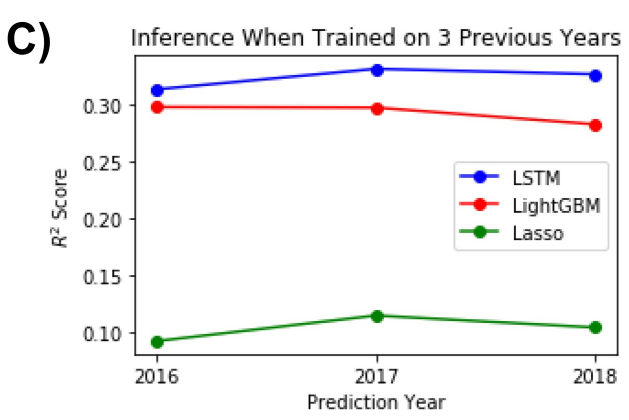


B)

Table 2: Test R^2 score for year 2016 (N = # of training examples)

Training Year(s)		Lasso	LightGBM	LSTM_{mh_attn}
2015	$N = 10K$	0.0381	**0.1918**	0.1551
	$N = 100K$	0.0372	0.2604	**0.2668**
	$N = 500K$	0.0367	0.2854	**0.2974**
2014, 2015	$N = 10K$	0.0744	**0.2167**	0.1954
	$N = 100K$	0.0750	0.2839	**0.2886**
	$N = 500K$	0.0752	0.3094	**0.3259**
2013, 2014, 2015	$N = 10K$	0.0925	**0.2416**	0.2080
	$N = 100K$	0.0918	0.2974	**0.3129**
	$N = 500K$	0.0913	0.3248	**0.3436**

C)



A) Outline of the model used in [3] for predicting the number of visits to a doctor next year, given individual treatment histories from previous years. The model was trained using pseudonymized out-patient data (AvoHILMO) on 1.4M elderly Finnish individual from years 2012-2018. **B)** Prediction accuracy of the model with different sizes of the training sets and lengths of treatment histories. **C)** These results demonstrate that the model generalizes well to future years (2017, 2018) from which no data were used when training the model.

References

[1] Lin, J., et al. (2020). MetaPhat: Detecting and decomposing multivariate associations from univariate genome-wide association statistics. *Frontiers in Genetics*.

[2] Mars, N., et al. (2020). Polygenic and clinical risk scores and their impact on age at onset and prediction of cardiometabolic diseases and common cancers. *Nature Medicine*.

[3] Colijn, C., et al. (2020). Designing ecologically optimized pneumococcal vaccines using population genomics. *Nature Microbiology*.

[4] Kumar, Y., et al. (2020). Predicting utilization of healthcare services from individual disease trajectories using RNNs with multi-headed attention. *PMLR: Machine Learning for Health (ML4H) at NeurIPS 2019.*

[5] Sundin, Peltola, et al. (2018). Improving genomics-based predictions for precision medicine through active elicitation of expert knowledge. *Bioinformatics*.

[6] Jaskari, J., et al. (2020). Deep Learning Method for Mandibular Canal Segmentation in Dental Cone Beam Computed Tomography Volumes. *Scientific reports.*

[7] Järvenpää, M., et al. (2019). Efficient acquisition rules for model-based approximate Bayesian computation. *Bayesian Analysis.*

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Finnish Center for Artificial Intelligence FCAI is a community of experts in artificial intelligence in Finland, initiated by Aalto University, University of Helsinki, and VTT Technical Research Centre of Finland. FCAI is one of the six Academy of Finland Finnish flagships.

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